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The other authors are Kenneth Short, Nasir Jaffery, Gordon Cooke, and John Riedener.

14. ABSTRACT
This poster reports the findings from four experimental investigations of the effectiveness of tools and technologies that may be employed, or have been considered for employment, in military operations at tactical checkpoints in daylight conditions. The items under investigation included the B.E. Meyers green beam designator (GBD-III-C), high intensity red, green, and white light (Multi-Chromatic Non-Coherent (MCNC) light), and windshield obscuration. The laser and MCNC light were evaluated for their hailing and warning capabilities or, in other words, their ability to communicate a warning to a driver that is approaching a checkpoint. The laser, MCNC light, and the windshield obscuration were evaluated for their suppression capabilities (ability to suppress or stop a driver from proceeding towards the tactical checkpoint). Effectiveness of devices for hailing and warning was measured by how reliably the stimuli were perceived and understood, what percentage of the time the device caused compliance in a non-hostile driver, and time taken to comply with instructions. Effectiveness of devices for suppressing and stopping was measured by whether the stimuli were sufficiently averse to: (1) convince the driver to choose to stop, (2) impair the ability of driver to navigate or successfully operate the vehicle, or (3) impair the ability of the driver enough to cause a forced stop.

15. SUBJECT TERMS
non-lethal weapons, effectiveness metrics, driving, lasers, green laser distractor, optical suppression, human behavior, checkpoint, ambient light, driver suppression, human experimentation, light, paintball, obscuration, hail, warning, suppression, stop

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The Armament Research Development & Engineering Center

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Tactical Checkpoint: Hail/Warn Suppress/Stop

Target Behavioral Response Laboratory

Elizabeth Mezzacappa, Ph.D.; Charles Sheridan, BA; Robert DeMarco, MSBME; Kevin Tevis, BSME; Gladstone Reid, MSBME; Kenneth Short, Ph.D.; Nasir Jaffery, BSEE, MBA; Gordon Cooke, MEME; John Riedener, MSSE

The Problem

Checkpoints are critical to peacekeeping and counterinsurgency operations. Security is a prime concern because checkpoints are often scenes of violence or have the threat of violence. Losses occur when using lethal fire on non-belligerents drivers mistakenly perceived to be a threat.

Specific Objectives

To compare the effectiveness of several non-lethal energies, methods, and modalities

For Hailing and Warning

To identify non-lethal devices and methods that can be unequivocally perceived and understood

For Suppression

To identify effective non-lethal means to impede a driver's approach to a checkpoint

Method

30 Drivers/Four Experiments/ 2x per condition

Hail/Warn Track

Three Hail/Warn Experiments

Can subject see/hear/understand and comply with instructions?

Red, green, white non-coherent lights, Green dazzling laser

Suppression Track

Suppression Experiment

Does the driver hesitate, slow down, or stop?

Bright white light, Paintball windshield obscuration, Green dazzling laser

Baselines Included
(no light stimulus/obscurant presented)

Lanes & Pressure Hoses

Instrumentation

Testbed: Pressure hoses, Videorecorder

Vehicle: Depressions of brake, Potentiometer recording of wheel turning, Accelerometer, Three video cameras (views of driver and driver's view out of front windshield)

Instrumented Vehicle

First Hail/Warn Experiment: Natural Reactions

Drivers drove in a straight path, traveling down the middle of the three-channel lane. Light stimuli (randomized order) presented 10m from the entrance to the channels

1.4-sec laser exposures

1-sec exposures of green, red, or white lights

Question

What is the driver's natural reaction to these light stimuli when presented while driving?

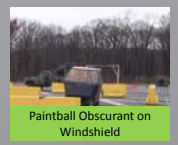
Findings

No subject naturally stopped in response to any of the light stimuli. The most frequent natural response to laser or non-coherent light stimuli: continue on straight as usual. No difference was noted in responses to each of the light stimuli.

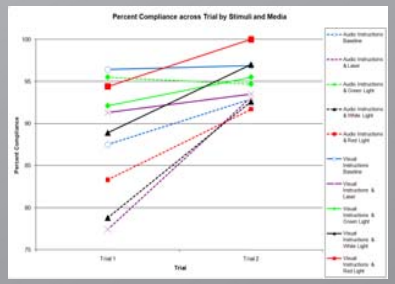
Red Non-Coherent Light Stimulus

White Non-Coherent Light Stimulus

Green Laser Distractor Light Stimulus



Paintball Obscurant on Windshield



Second Hail/Warn Experiment: Understandability

Visual signs and auditory messages were paired with each of the light conditions.

Question

Do subjects comply with instructions delivered in combination with the hailing and warning stimuli?

Findings

No significant differences detected among the laser or light stimuli in terms of compliance with instructions. Significant differences in compliance with the first versus second presentation of auditory instructions, such that the second presentation of instructions elicited greater compliance.

Third Hail/Warn Experiment: Perceptibility

Subjects were informed ahead of time what to do when presented with each light stimulus: White Light- "Take Right Channel"; Green Light (laser or non-coherent)- "Take Left Channel"; Red Light- "Stop"; If don't see light- "Go Straight"

Question

Can subjects perceive the light stimuli?

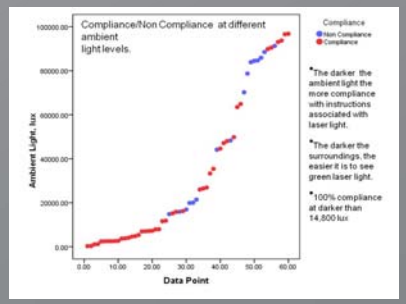
Assumption: drivers do not follow instructions when they do not perceive the light stimulus.

Comparison: driver's compliance reactions to the different light stimuli

Conclusion: different reactions reflect different perceptibility of light stimuli

Findings

No differences in perceptibility among the different wavelengths of non-coherent colored lights. Laser was harder to see than the non-coherent lights (lower compliance when laser was presented). Significant negative correlation between ambient light and compliance rates under the laser presentation-- in other words, in darker settings it is reliably easier to see this laser light.



Suppression Experiment

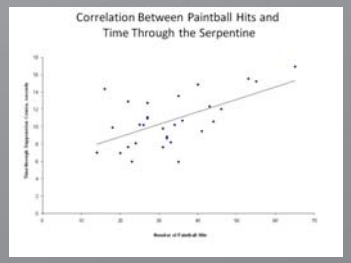
Subjects were exposed to potentially suppressive stimuli prior to driving a serpentine course: Green dazzling laser, Non-coherent bright white light, Windshield obscurants

Question

Do any of the three stimuli produce a suppressive effect? Can we make the driver choose to stop? Can we make the driver lose control of the vehicle? Can we make the driver hesitate? Can we make the driver slow down?

Findings

No driver stopped. No driver hesitated upon entering serpentine. No driver slowed down while navigating the serpentine. Positive correlation between number of paintballs that hit the windshield and the time to drive through serpentine.



Conclusions

Perceptibility is the key to compliance.

The most effective hail/warn non-lethal system is the one that can be seen and/or heard by the drivers.

In the day, compared with standard non-coherent light sources, laser light devices are more difficult to see.

Multiple presentations of instructions are more effective at conveying the instructions of the message.

In the daytime, lasers are ineffective in suppressing drivers approaching checkpoints at distances required for the target's safety (for this device, 47 m).

None of the stimuli made drivers stop instinctively or reflexively. Even in subjects who were highly motivated to avoid hitting or contacting any barriers in the serpentine course, there was never a case where a subject chose to stop the vehicle for fear of crashing.

Obscurants, methods of blocking the drivers from seeing where they are going, appear to be the most promising avenue of further research for suppressive effectiveness.

TBRL Gather empirical data on real human behavior in response to non-lethal weapons and systems using real people in tactically relevant situations TBRL

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